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Enclosed are:

- ☒ [X] Specification, Claim(s), and Abstract (40 pages).
- ☒ [X] Formal drawings (8 sheets, Figures 1-12)
- ☒ [X] Declaration and Power of Attorney (2 pages)
- ☒ [X] Associate Power of Attorney
- ☒ [X] Assignment to TOSHIBA TEC KABUSHIKI KAISHA
- ☒ [X] Assignment Recordation Form Cover Sheet
- ☒ [X] Information Disclosure Statement
- ☒ [X] Form PTO-1449 and 1 reference(s)

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TITLE OF THE INVENTION

IMAGE FORMING APPARATUS AND IMAGE FORMING METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

5 This application is based upon and claims the
benefit of priority from the prior Japanese Patent
Application No. 11-232735, filed August 19, 1999, the
entire contents of which are incorporated herein by
reference.

BACKGROUND OF THE INVENTION

10 The present invention relates to an image forming
apparatus for subjecting an input image signal to, for
example, a color conversion process, an enlargement/
reduction process, etc. in an image forming apparatus,
such as a digital copying machine, which reads a color
15 image on an original and produces a copy image thereof.

In general, in a digital copying machine or a
laser printer, in order to produce an output image
which is clearer and favorably accepted by users, an
original to be input or an input image signal is
20 discriminated into a character portion and other
portions in units of a pixel or an area by using a
discrimination signal, and an image processing method
to be carried out within the digital copying machine or
laser printer is switched according to the discrimina-
25 tion signal.

Where an input image is to be enlarged or reduced
to produce an output image at the request of the user,

the discrimination signal, too, may be enlarged/reduced in addition to the enlargement/reduction of the input image, depending on the scheme of the image processing. In the prior art, a fixed discrimination signal has
5 been enlarged/reduced by arithmetic operations, irrespective of characteristics of the input image.

However, there is a case where a proper image process varies depending on whether the input image is an image with emphasis on a gray scale, such as a
10 photographic image, or a character image, or a color image, or a black-and-white image. If the discrimination signal is merely enlarged/reduced without considering this matter, the obtained discrimination signal may designate an image process
15 which is not suitable for the characteristic of the image on the original.

BRIEF SUMMARY OF THE INVENTION

An object of the present invention is to provide an image processing apparatus and an image forming
20 method capable of performing an enlargement/reduction process with less error relative to an image on an original, thereby producing a high-quality output image.

Another object of the invention is to provide an image processing apparatus and an image forming method
25 capable of producing, where an input image is a color image, an output image with still higher quality, by taking into account the image characteristic or

first discrimination means for generating a first
5 discrimination signal by determining an attribute of
each of at least one area obtained by dividing an input
image on the basis of the input image signal;

image enlargement/reduction means for subjecting
the input image signal to the enlargement/reduction
15 process on the basis of the enlargement/reduction
magnification;

image processing means for performing an image
process for the enlarged/reduced image signal from the
image enlargement/reduction means on the basis of the
25 third discrimination signal.

subjecting an input image signal to an enlargement/
reduction process on the basis of a predetermined
enlargement/reduction magnification, the method
comprising the steps of:

5 generating a first discrimination signal by
determining an attribute of each of pixels on the basis
of the input image signal;

 subjecting the input image signal to the
enlargement/reduction process on the basis of the
10 enlargement/reduction magnification;

 generating a second discrimination signal by
subjecting the first discrimination signal from the
first discrimination means to the enlargement/reduction
process on the basis of the enlargement/reduction
15 magnification; and

 performing an image process for the
enlarged/reduced image signal from the image
enlargement/reduction means on the basis of the second
discrimination signal.

20 Additional objects and advantages of the invention
will be set forth in the description which follows, and
in part will be obvious from the description, or may be
learned by practice of the invention. The objects and
advantages of the invention may be realized and
25 obtained by means of the instrumentalities and
combinations particularly pointed out hereinafter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiments of the invention, and together with the general description given above and the detailed description of the preferred embodiments given below, serve to explain the principles of the invention.

FIG. 1 is a side view schematically showing an internal structure of an image forming apparatus to which image processing apparatuses according to embodiments of the present invention are applied;

FIG. 2 is a block diagram schematically showing electrical connection of the image forming apparatus shown in FIG. 1 and flow of signals for control;

FIG. 3 is a block diagram showing a structure of the image processing apparatus shown in FIG. 2 according to a first embodiment of the invention;

FIG. 4 is a block diagram showing the structure of a discrimination signal enlargement/reduction unit shown in FIG. 3;

FIG. 5 is a view for explaining an operation of a pixel division section shown in FIG. 4;

FIG. 6 is a view for explaining an OR operation in an enlargement/reduction arithmetic section shown in FIG. 4;

FIG. 7 is a view for explaining an AND operation

in the enlargement/reduction arithmetic section shown in FIG. 4;

FIG. 8 is a block diagram showing a structure of the image processing apparatus shown in FIG. 2 according to a second embodiment of the invention;

FIG. 9 is a view for explaining a first example of a weighted sum mean arithmetic operation in the enlargement/reduction arithmetic section shown in FIG. 4;

FIG. 10 is a view for explaining a second example of a weighted sum mean arithmetic operation in the enlargement/reduction arithmetic section shown in FIG. 4;

FIG. 11 is a view for explaining an example of the operation of the enlargement/reduction arithmetic section shown in FIG. 4, in which maximum value selection is adopted; and

FIG. 12 is a view for explaining an example of the operation of the enlargement/reduction arithmetic section shown in FIG. 4, in which minimum value selection is adopted.

DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the present invention will now be described with reference to the accompanying drawings.

A first embodiment of the invention will be described below.

FIG. 1 schematically shows an internal structure

of an image forming apparatus such as a digital color copying machine for reading a color image on an original and producing a copy image thereof. To this image forming apparatus, the image processing apparatus according to the present invention is applied.

In general terms, the image forming apparatus comprises a color scanner section 1 serving as image input means for reading and inputting a color image on an original, and a color printer section 2 serving as image output means for producing a copy image of the input color image.

The color scanner section 1 has an original table cover 3 on its upper part, and an original table 4 formed of transparent glass and disposed to face the original table cover 3 in the closed state. An original is placed on the original table 4. Below the original table 4, there are provided an exposure lamp 5 for illuminating the original placed on the original table 4; a reflector 6 for converging light from the exposure lamp 5 onto the original; and a first mirror 7 for deflecting the reflection light from the original to the left (in FIG. 1). The exposure lamp 5, reflector 6 and first mirror 7 are fixed to a first carriage 8. The first carriage 8 is driven by a pulse motor (not shown) by means of a toothed belt (not shown), etc. so that the first carriage 8 may be moved in parallel along the lower surface of the original

table 4.

A second carriage 9 is disposed on the left side (in FIG. 1) of the first carriage 8, that is, on the side to which reflection light from the first mirror 7 is guided. The second carriage 9 is movable in parallel to the original table 4 by means of a drive mechanism (not shown) (e.g. a toothed belt and a DC motor). The second carriage 9 comprises a second mirror 11 for downwardly deflecting the reflection light from the original which has been guided by the first mirror 7, and a third mirror 12 for deflecting the reflection from the second mirror 11 to the right in FIG. 1. The second mirror 11 and third mirror 12 are disposed at right angles to each other. The second carriage 9 follows the movement of the first carriage 8 and moves in parallel to the original table 4 at a speed equal to half the speed of the first carriage 8.

A focusing lens 13 for focusing the reflection light from the third mirror 12 at a predetermined magnification is disposed in a plane including an optical axis of the light deflected by the second and third mirrors 11 and 12. A CCD color image sensor (photoelectric conversion element) 15 for converting the reflection light converged by the focusing lens 13 to an electric signal is disposed in a plane substantially perpendicular to the optical axis of the light traveling through the focusing lens 13.

If light from the exposure lamp 5 is converged onto the original placed on the original table 4 by means of the reflector 6, the reflection light from the original is made incident on the color image sensor 15 via the first mirror 7, second mirror 11, third mirror 12 and focusing lens 13. The color image sensor 15 converts the incident light to electric signals of the three primary colors, R (red), G (green) and B (blue).

The color printer section 2 has first to fourth image forming units 10y, 10m, 10c and 10k for producing images of four colors, yellow (Y), magenta (M), cyan (C) and black (K), which are color-separated according to a well-known subtractive color mixing process.

A convey mechanism 20 is disposed below the image forming units 10y, 10m, 10c and 10k. The convey mechanism 20 includes a convey belt 21 serving as convey means for conveying color images produced by the respective image forming units in a direction indicated by an arrow a. The convey belt 21 is passed between a driving roller 91 rotated by a motor (not shown) in the direction of arrow a and a driven roller 92 disposed apart from the driving roller 91 by a predetermined distance. The convey belt 21 is endlessly run in the direction of arrow a at a fixed speed. The image forming units 10y, 10m, 10c and 10k are arranged in tandem in the direction of conveyance of the convey belt 21.

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main scan direction; a lower stirring roller 67y, 67m, 67c, 67k; an upper stirring roller 68y, 68m, 68c, 68k; a transfer device 93y, 93m, 93c, 93k serving as transfer means, similarly extended in the main scan
5 direction; a cleaning blade 65y, 65m, 65c, 65k similarly extended in the main scan direction; and a waste toner recovering screw 66y, 66m, 66c, 66k.

Each transfer device 93y, 93m, 93c, 93k is disposed at such a position as to sandwich the convey
10 belt 21 between itself and the photosensitive drum 61y, 61m, 61c, 61k, that is, inside the convey belt 21. In addition, an exposure point by an exposure device 50 (to be described later) is formed on that portion of the outer peripheral surface of each photosensitive
15 drum 61y, 61m, 61c, 61k, which lies between the charging device 62y, 62m, 62c, 62k and the developing roller 64y, 64m, 64c, 64k.

Sheet cassettes 22a, 22b containing paper sheets P as image formation media (recording media), on which
20 images formed by the image forming units 10y, 10m, 10c, 10k are to be transferred, are disposed below the convey mechanism 20.

A pick-up roller 23a, 23b is disposed at one end of each of the sheet cassettes 22a, 22b. The pick-up
25 roller 23a, 23b picks up sheets P one by one from the uppermost one from the sheet cassette 22a, 22b.

Register rollers 24 are disposed between the pickup

rollers 23a, 23b and the driven roller 92. The register rollers 24 register and align a leading edge of the sheet P picked up from the sheet cassette 22a, 22b with a leading edge of a y-toner image formed on the photosensitive drum 61y of the image forming unit 10y.

Toner images formed on the other photosensitive drums 61m, 61c and 61k are brought to respective transfer positions in accordance with the transfer timing of the sheet P conveyed on the convey belt 21.

An attraction roller 26 for providing an electrostatic attraction force to the sheet P conveyed at the predetermined timing via the register rollers 24 is disposed between the register rollers 24 and the first image forming unit 10y, and near the driven roller 92, that is, substantially over the outer peripheral surface of the driven roller 92 with the convey belt 21 interposed. The axis of the attraction roller 26 and the axis of the driven roller 92 are set to be parallel to each other.

A position error sensor 96 for sensing a position of the image formed on the sheet P on the convey belt 21 is disposed in a region at one end of the convey belt 21, and near the driving roller 91, that is, substantially over the outer peripheral surface of the driving roller 91 with the convey belt 21 interposed. The position error sensor 96 comprises, for example, a

light transmission type or a light reflection type optical sensor.

5 A convey belt cleaning device 95 for removing toner adhering to the convey belt 21 or paper dust of the sheet P is disposed at the outer peripheral surface of the driving roller 91, in contact with the convey belt 21 on the downstream side of the position error sensor 96.

10 A fixing device 80 is disposed in a region to which the sheet P conveyed by the convey belt 21 and separated from the driving roller 91 is delivered. The fixing device 80 heats the sheet P at a predetermined temperature, melts the toner image transferred on the sheet P, and fixes the toner image on the sheet P. The
15 fixing device 80 comprises a heat roller pair 81, oil apply rollers 82 and 83, a web winding roller 84, a web roller 85, and a web press roller 86. The toner on the sheet P is fixed and the sheet P with the fixed toner image is discharged by a discharge roller pair 87.

20 The exposure device 50 forms color-separated electrostatic latent images on outer peripheral surfaces of the respective photosensitive drums 61y, 61m, 61c and 61k. The exposure device 50 has a semiconductor laser 60. The light emission from the
25 semiconductor laser 60 is controlled on the basis of image data (Y, M, C, K) of respective colors separated by an image processing apparatus 63 (to be described

below). A polygon mirror 51 rotated by a polygon motor 54 to reflect and scan laser beams and $f\theta$ lenses 52 and 53 for focusing the laser beams reflected by the polygon mirror 51 by correcting their focal points are disposed in the named order along the optical path of the semiconductor laser 60.

First deflection mirrors 55y, 55m, 55c and 55k for deflecting the respective color laser beams emanating from the $f\theta$ lens 53 toward the exposure points on the photosensitive drums 61y, 61m, 61c and 61k, and second and third deflection mirrors 56y, 56m, 56c, 57y, 57m and 57c for further deflecting the laser beams deflected by the first deflection mirrors 55y, 55m and 55c are disposed between the $f\theta$ lens 53 and the photosensitive drums 61y, 61m, 61c and 61k.

The laser beam for black is deflected by the first deflection mirror 55k and then directly guided to the photosensitive drum 61k without intervention of other mirrors.

FIG. 2 is a block diagram schematically showing electrical connection of the image forming apparatus shown in FIG. 1 and flow of signals for control. In FIG. 2, a control system comprises three CPUs (Central Control Units): a main CPU 91 provided in a main control section 30; a scanner CPU 100 in the color scanner section 1; and a printer CPU 110 in the color printer section 2.

The main CPU 91 performs bi-directional communication with the printer CPU 110 via a shared RAM (Random Access Memory) 35. The main CPU 91 issues an operational instruction, and the printer CPU 110 returns status data. Serial communication is performed between the printer CPU 110 and scanner CPU 100. The printer CPU 110 issues an operational instruction, and the scanner CPU 100 returns status data.

An operation panel 40 comprises a liquid crystal display (LCD) 42, various operation keys 43 and a panel CPU to which the LCD 42 and operation keys 43 are connected. The operation panel 40 is connected to the main CPU 91.

The main control section 30 comprises the main CPU 91, a ROM (Read-Only Memory) 32, a RAM 33, an NVRAM 34, shared RAM 35, image processing apparatus 36, a page memory control unit 37, a page memory 38, a printer controller 39, and a printer font ROM 121.

The main CPU 91 controls the entirety of the main control section 30. The ROM 32 stores control programs, etc. The RAM 33 temporarily stores data.

The NVRAM (Non-Volatile RAM) 34 is a non-volatile memory backed up by a battery (not shown). Even when power is not supplied to the NVRAM 34, stored data is maintained.

The shared RAM 35 is used to perform bi-directional communication between the main CPU 91 and

printer CPU 110.

The page memory control unit 37 stores and read out image information in and from the page memory 38. The page memory 38 has areas capable of storing image information of a plurality of pages. The page memory 38 can store compressed data in units of a page, which is obtained by compressing image information from the color scanner section 1.

The printer font ROM 121 stores font data corresponding to print data. The printer controller 39 develops print data, which is sent from an external device 122 such as a personal computer, into image data using the font data stored in the printer font ROM 121, with a resolution corresponding to resolution data added to the print data.

The color scanner section 1 comprises the scanner CPU 100 for controlling the entirety of the color scanner section 1; a ROM 101 storing control programs, etc.; a data storage RAM 102; a CCD driver 103 for driving the color image sensor 15; a scan motor driver 104 for controlling the rotation of a scan motor for moving the first carriage 8, etc.; and an image correction unit 105.

The image correction section 105 comprises an A/D converter for converting R-, G- and B-analog signals output from the color image sensor 15 to digital signals; a shading correction circuit for correcting a

variance in the color image sensor 15 or a variation in threshold level due to ambient temperature variation relative to the output signal from the color image sensor 15; and a line memory for temporarily storing shading-corrected digital signals from the shading correction circuit.

The color printer section 2 comprises the printer CPU 110 for controlling the entirety of the color printer section 2; a ROM 111 storing control programs, etc.; a data storage RAM 112; a laser driver 113 for driving the semiconductor laser 60; a polygon motor driver 114 for driving the polygon motor 54 of the exposure device 50; a convey control unit 115 for controlling conveyance of the sheet P by the convey mechanism 20; a process control section 116 for controlling charging, developing and transferring processes using the charging device, developing roller and transfer device; a fixation control unit 117 for controlling the fixing device 80; and an option control unit 118 for control options.

The image processing apparatus 36, page memory 38, printer controller 39, image correction unit 105 and laser driver 113 are connected over an image data bus 120.

FIG. 3 schematically shows the structure of the image processing apparatus 36. The image processing apparatus 36 comprises an input section 200 for

subjecting image data from the color scanner section 1
to a color conversion process, etc.; a discrimination
section 210 serving as discrimination means for
producing a discrimination signal indicative of
5 "character", "non-character", etc. on the basis of an
image signal (to be also referred to as "image data")
from the input section 200; a first processing section
220 serving as first image processing means for
subjecting the image signal from the input section 200
10 to a filtering process, etc. and switching the
processing method, etc. in accordance with the
discrimination signal produced by the discrimination
section 210; an enlargement/reduction section 230
serving as enlargement/reduction means for
15 enlarging/reducing the discrimination signal from the
discrimination section 210 and the image signal from
the first processing section 220; a second processing
section 240 serving as image processing means for
subjecting the enlarged/reduced image signal from the
20 enlargement/reduction section 230 to a black-added
printing process, a gamma conversion process, etc. and
switching the processing method, etc. in accordance
with the enlarged/reduced discrimination signal from
the enlargement/reduction section 230; and an output
25 section 250 for processing the image signal from the
second processing section 240 to produce a printer
output signal.

A detailed description will now be given of the respective sections.

The input section 200 subjects the image data from the color scanner section 1 to an input process.

5 Specifically, if a color image process is to be performed in a subsequent stage, the input section 200 converts the R-, G- and B-image data from the color scanner section 1 to three-primary-color image data C (cyan), image data M (magenta) and image data Y (yellow) for controlling color materials for image
10 formation in the color printer section 2. Various methods, such as masking equations, may be used for the color conversion. If a black-and-white image process is to be performed in a subsequent stage, the input
15 section 200 produces a K (black) signal from the R-, G- and B-image data from the color scanner section 1 according to a conversion equation, e.g. $K = \{(1-R) + (1-G) + (1-B)\} / 3$.

The thus produced C-, M- and Y-image data or the K
20 signal, and the input R-, G- and B-image data are delivered to subsequent-stage sections such as the discrimination section 210 and first processing section 220.

The discrimination section 210 comprises an area
25 discrimination unit 211 and an attribute discrimination unit 212. The area discrimination unit 211 generates frequency characteristic quantities from the R-, G- and

B-image data from the color scanner section 1 and
subjecting the generated frequency characteristic
quantities to a smearing process, etc., thereby
producing rectangular area discrimination signals. The
5 rectangular area discrimination signals are sent to the
attribute discrimination unit 212. The rectangular
area discrimination signals represent area kinds such
as "character area", "photography area" and "background
area."

10 The R-, G- and B-image data input to the area
discrimination section 211 is R-, G- and B-image data
input by a pre-scan which is carried out prior to a
main scan performed at the time of copying. In general,
the pre-scan is performed at a lower resolution and at
15 a higher speed than in the main scan.

The attribute discrimination section 212 generates
differential characteristic quantities from the C-, M-
and Y-image data or the K-signal from the input section
200 and subjects the generated qualities to an
20 expansion process, etc., thereby producing character
discrimination signals. In addition, depending on the
purpose of use, the characteristic for discrimination
is switched according to the rectangular area
discrimination signals from the area discrimination
25 section 211. The discrimination signals include,
for example, a CMY discrimination signal and a K
discrimination signal. The discrimination signal which

is required in the processing in the subsequent-stage sections is used.

5 The first processing section 220 comprises an image processing unit 221, an image processing unit 222 and an image signal switching unit 223. The number of first processing sections 220 corresponds to the number of colors, C, M, Y and K, and each first processing section 220 independently performs a process for the associated color.

10 The image processing unit 221, 222 subjects the image signal from the input section 200 to a high-level emphasis filter process for edge emphasis, a low-level filter process for reducing moire, e.g. mesh-like points on the original, a correction process for an
15 achromatic color area, etc. The image processing unit 221 and image processing unit 222, however, have different filtering characteristics, achromatic process characteristics, etc.

20 The image signal switching unit 223 selects one of the output from the image processing unit 221 and the output from the image processing unit 222 in accordance with the discrimination signal from the discrimination section 210. For example, in accordance with the
25 discrimination signal representing "character" or "non-character," a signal with emphasis on contour may be selected for a pixel of a character portion and a signal with smoothness may be selected for a pixel of a

with the discrimination signal from the discrimination
signal enlargement/reduction unit 232. For example, in
accordance with the discrimination signal representing
"character" or "non-character," a processed result
5 matching with the pixel may be selected.

A detailed description will now be given of the
discrimination signal enlargement/reduction unit 232 in
the enlargement/reduction section 230, which is most
important for the present invention.

FIG. 4 shows the structure of the discrimination
signal enlargement/reduction unit 232 which comprises,
in general terms, a pixel division section 300 and an
enlargement/reduction arithmetic section 310. The
pixel division section 300 receives the discrimination
15 signal from the discrimination section 210, divides the
associated pixels in accordance with a magnification
instructed by the main CPU 91 or a magnification
determined by a 2-in-1 function by which one copy is
produced from two originals, and retains the divided
20 pixels.

The number of division of pixels is calculated
from an inverse number of the magnification. For
example, where the magnification is 50%, $1 \div 0.5 = 2$.
Thus, the pixels associated with the discrimination
25 signal are divided in units of two pixels and the
divided pixels are retained. Where the magnification
is 200%, $1 \div 2 = 0.5$. Thus, the pixels are divided in

arithmetic operation such as an OR operation (logical sum operation), as illustrated in FIG. 6, or an AND operation (logical product operation), as illustrated in FIG. 7. As regards the enlarged/reduced discrimination signal obtained by these operations, the number of pixels with value "1" is large in the case of the OR operation and the number of pixels with value "0" is large in the case of the AND operation.

Assume that the discrimination signal with value "1" represents a character pixel, and the discrimination signal with value "0" represents a non-character pixel. Where the discrimination signal is reduced by the OR operation, the number of character pixels becomes large. Where the discrimination signal is reduced by the AND operation, the number of non-character pixels becomes large.

The enlarged/reduced discrimination signal switching unit 314 selects one of the enlarged/reduced discrimination signals obtained by the above-described different arithmetic operations, that is, one of the output signals from the operation units 311, 312 and 313, on the basis of information on an original mode, a color mode, etc. from the main CPU 91 or the discrimination signal from the area discrimination unit 211. If patterns of selection are predetermined in consideration of the characteristics of the above-described arithmetic operations, discrimination signals

for designating image processes more suitable for the purpose of print output can be generated.

The respective components of the discrimination enlargement/reduction unit 232 are controlled by the main CPU 91. As regards data which needs to be supplied in advance to the associated section or unit, the main CPU 91 accesses the storage means such as ROM 32 and supplies such data to the associated section or unit.

A second embodiment of the present invention will now be described.

FIG. 8 schematically shows the structure of the image processing apparatus 36 wherein a multi-value discrimination signal is produced. This image processing apparatus 36 differs from the image processing apparatus 36 of the first embodiment (FIG. 3) in that the number of image processing units in the first processing section 220 and the second processing section 240, which can be switched by the discrimination signal, is not two but three or more represented by the multi-value discrimination signal. In the embodiment shown in FIG. 8, the first processing section 220 includes seven image processing units 2211 to 2217 having mutually different filter characteristics and achromatic process characteristics. The second processing section 240 includes seven image processing units 2421 to 2427 having mutually different

gamma correction characteristics and black-added printing process characteristics.

FIG. 9 shows a case where the weighted sum mean arithmetic operation is performed. Although the same is applicable to the case of the two-value signal, a description will now be given of the case of a multi-value signal which is considered particularly useful. Like FIG. 5, FIG. 9 shows a case where the magnification is 40%. Since the object pixel range is 2.2 pixels, both end pixels in each object pixel range are made to reflect designated ratios.

A specific example is shown in FIG. 10. Consider the 2.2 pixels of the first object pixel range. Since the magnification is 40%, $a = 1$, $b = 1$ and $c = 0.2$. If the values of pixels are $A = 2$, $B = 3$ and $C = 4$, the obtained reduced discrimination signal corresponding to one pixel is given by the formula below. The obtained value is rounded to 3, and a discrimination signal with value "3" is output.

$$\frac{a*A + b*B + c*C}{a + b + c} = \frac{1*2 + 1*3 + 0.2*4}{2.2} \approx 2.636$$

In general, the method of reflecting the designated ratios in the object pixel range is called a projection method in the reduction process, or a linear interpolation method in the enlargement process.

Apart from the weighted sum mean arithmetic operation, a maximum value selection operation in which a maximum value in the object pixel range is selected,

a minimum value selection operation, and a mean value selection operation can be applied to the enlargement/reduction operations.

FIG. 11 illustrates an example of the maximum value selection operation for selecting the maximum value of the pixels in the object pixel range. FIG. 12 illustrates an example of the minimum value selection operation for selecting the minimum value of the pixels in the object pixel range. As is obvious from these figures, the maximum value selection provides a reduced discrimination signal with a greater value, and the minimum value selection provides a reduced discrimination signal with a less value.

Assume that a discrimination signal with value "7" indicates a character pixel, a discrimination signal with value "0" indicates a non-character pixel, and a discrimination value with an intermediate value indicates "the possibility of being a character pixel" according to the value. Thus, the greater the value of the discrimination signal, the higher the possibility of being a character pixel. The discrimination signal reduced by the maximum value selection may represent more character-like pixels, and the discrimination signal reduced by the minimum value selection may represent more non-character-like pixels. Where the discrimination signal is reduced by the projection method, it may have characteristics between the maximum

value selection and minimum value selection.

Like the case where the discrimination signal is a two-value signal, the enlarged/reduced discrimination signal switching unit 314 selects one of the enlarged/reduced discrimination signals obtained by the above-described different arithmetic operations, on the basis of information on an original mode, a color mode, etc. from the main CPU 91 or the discrimination signal from the area discrimination unit 211. If patterns of selection are predetermined in consideration of the characteristics of the above-described arithmetic operations, discrimination signals for designating image processes more suitable for the purpose of print output can be generated.

As has been described above in detail, according to the present invention, the enlargement/reduction process method for the discrimination signal is switched on the basis of the characteristics of the input image. Based on the obtained discrimination signal, the image process matching with the input image is selected. Thereby, this invention can provide an image processing apparatus and an image forming method capable of performing an enlargement/reduction process with less error relative to an image on an original, thereby producing a high-quality output image.

Moreover, this invention can provide an image processing apparatus and an image forming method

capable of producing, where an input image is a color image, an output image with still higher quality, by taking into account the image characteristic or chromatic characteristic associated with each of the colors of the image.

Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

WHAT IS CLAIMED IS:

1. An image processing apparatus for subjecting
an input image signal to an enlargement/reduction
process on the basis of a predetermined enlargement/
5 reduction magnification, the apparatus comprising:

first discrimination means for generating a first
discrimination signal by determining an attribute of
each of pixels on the basis of the input image signal;

10 image enlargement/reduction means for subjecting
the input image signal to the enlargement/reduction
process on the basis of the enlargement/reduction
magnification;

second discrimination means for generating a
second discrimination signal by subjecting the first
15 discrimination signal from the first discrimination
means to the enlargement/reduction process on the basis
of the enlargement/reduction magnification; and

image processing means for performing an image
process for the enlarged/reduced image signal from the
20 image enlargement/reduction means on the basis of the
second discrimination signal.

2. An image processing apparatus according to
claim 1, wherein the first discrimination signal
generated by the first discrimination means is a two-
25 value signal.

3. An image processing apparatus according to
claim 1, wherein the first discrimination signal

generated by the first discrimination means is a multi-value signal.

4. An image processing apparatus according to claim 1, wherein an image signal selected by the first discrimination signal from the first discrimination means from among image signals processed and output from a plurality of image processing units, which have mutually different characteristics for applying a predetermined image process to the input image signal, is subjected by said image enlargement/reduction means to the enlargement/reduction process on the basis of the enlargement/reduction magnification.

5. An image processing apparatus according to claim 1, wherein said second discrimination means comprises:

pixel division means for dividing pixel information associated with the first discrimination signal, which pixel information belongs to an object pixel range, on the basis of the enlargement/reduction magnification, and retaining the divided pixel information;

a plurality of arithmetic operation means for subjecting the pixel information belonging to the object pixel range, which has been divided by the pixel division means, to predetermined arithmetic operations, thereby outputting enlarged/reduced discrimination signals associated with the pixels; and

selection means for selecting one of the output signals from the plural arithmetic operation means on the basis of an externally provided switching condition.

5 6. An image processing apparatus according to claim 5, wherein the externally provided switching condition, which is input to the selection means, is one of an enlargement/reduction magnification, a kind of an original, and an image process adjustment value, which are selected by external input operations.

10 7. An image processing apparatus according to claim 5, wherein where the first discrimination signal generated by the first discrimination means is a two-value signal, each of the plural arithmetic operation means performs an arithmetic operation of one of a
15 logical sum of pixel information in an object range divided by the pixel division means, a logical product of the pixel information in the object range divided by the pixel division means, a pixel value at a fixed position such as a first pixel or a last pixel in the
20 object range, and a weighted sum corresponding to the magnification.

25 8. An image processing apparatus according to claim 5, wherein where the first discrimination signal generated by the first discrimination means is a multi-value signal, each of the plural arithmetic operation means performs an arithmetic operation of one of a pixel value at a fixed position, such as a first pixel

or a last pixel, of pixel information in an object range divided by the pixel division means, a maximum or minimum value of the pixel information in the object range, and a weighted sum corresponding to the magnification.

9. An image processing apparatus for subjecting an input image signal to an enlargement/reduction process on the basis of a predetermined enlargement/reduction magnification, the apparatus comprising:

first discrimination means for generating a first discrimination signal by determining an attribute of each of at least one area obtained by dividing an input image on the basis of the input image signal;

second discrimination means for generating a second discrimination signal by determining an attribute of each of pixels on the basis of the input image signal and the first discrimination signal from the first discrimination means;

image enlargement/reduction means for subjecting the input image signal to the enlargement/reduction process on the basis of the enlargement/reduction magnification;

third discrimination means for generating a third discrimination signal by subjecting the second discrimination signal from the second discrimination means to the enlargement/reduction process on the basis of the enlargement/reduction magnification; and

image processing means for performing an image process for the enlarged/reduced image signal from the image enlargement/reduction means on the basis of the third discrimination signal.

5 10. An image processing apparatus according to claim 9, wherein the second discrimination signal generated by the second discrimination means is a two-value signal.

10 11. An image processing apparatus according to claim 9, wherein the second discrimination signal generated by the second discrimination means is a multi-value signal.

15 12. An image processing apparatus according to claim 9, wherein said third discrimination means comprises:

pixel division means for dividing pixel information associated with the second discrimination signal from the second discrimination means, which pixel information belongs to an object pixel range, on the basis of the enlargement/reduction magnification, and retaining the divided pixel information;

20 a plurality of arithmetic operation means for subjecting the pixel information belonging to the object pixel range, which has been divided by the pixel division means, to predetermined arithmetic operations, thereby outputting enlarged/reduced attribute discrimination signals associated with the pixels; and

selection means for selecting one of the output signals from the plural arithmetic operation means on the basis of an externally provided switching condition and the first discrimination signal from the first discrimination means.

13. An image processing apparatus according to claim 12, wherein the externally provided switching condition, which is input to the selection means, is one of an enlargement/reduction magnification, a kind of an original, and an image process adjustment value, which are selected by external input operations.

14. An image processing apparatus according to claim 12, wherein where the second discrimination signal generated by the second discrimination means is a two-value signal, each of the plural arithmetic operation means of the third discrimination means performs an arithmetic operation of one of a logical sum of pixel information in an object range divided by the pixel division means, a logical product of the pixel information in the object range divided by the pixel division means, a pixel value at a fixed position such as a first pixel or a last pixel in the object range, and a weighted sum corresponding to the magnification.

15. An image processing apparatus according to claim 12, wherein where the second discrimination signal generated by the second discrimination means is

a multi-value signal, each of the plural arithmetic operation means of the third discrimination means performs an arithmetic operation of one of a pixel value at a fixed position, such as a first pixel or a last pixel, of pixel information in an object range divided by the pixel division means, a maximum or minimum value of the pixel information in the object range, and a weighted sum corresponding to the magnification.

- 10 16. An image processing method for subjecting an input image signal to an enlargement/reduction process on the basis of a predetermined enlargement/reduction magnification, the method comprising the steps of:
- 15 generating a first discrimination signal by determining an attribute of each of pixels on the basis of the input image signal;
- subjecting the input image signal to the enlargement/reduction process on the basis of the enlargement/reduction magnification;
- 20 generating a second discrimination signal by subjecting the first discrimination signal from the first discrimination means to the enlargement/reduction process on the basis of the enlargement/reduction magnification; and
- 25 performing an image process for the enlarged/reduced image signal from the image

[illegible]

ABSTRACT OF THE DISCLOSURE

An input section performs a color conversion process, etc. for image data from a color scanner section. A discrimination section generates a discrimination signal representative of "character", "non-character", etc. on the basis of an image signal from the input section. A first processing section performs a filtering process, etc. for the image signal from the input section, and switches the method of such a process on the basis of the discrimination signal from the discrimination section. An enlargement/reduction section enlarges or reduces the discrimination signal from the discrimination section and the image signal from the first processing section. A second processing section subjects the enlarged/reduced image signal from the enlargement/reduction section to a black-added printing process, a gamma conversion process, etc., and switches the method of such a process on the basis of the enlarged/reduced discrimination signal from the enlargement/reduction section.

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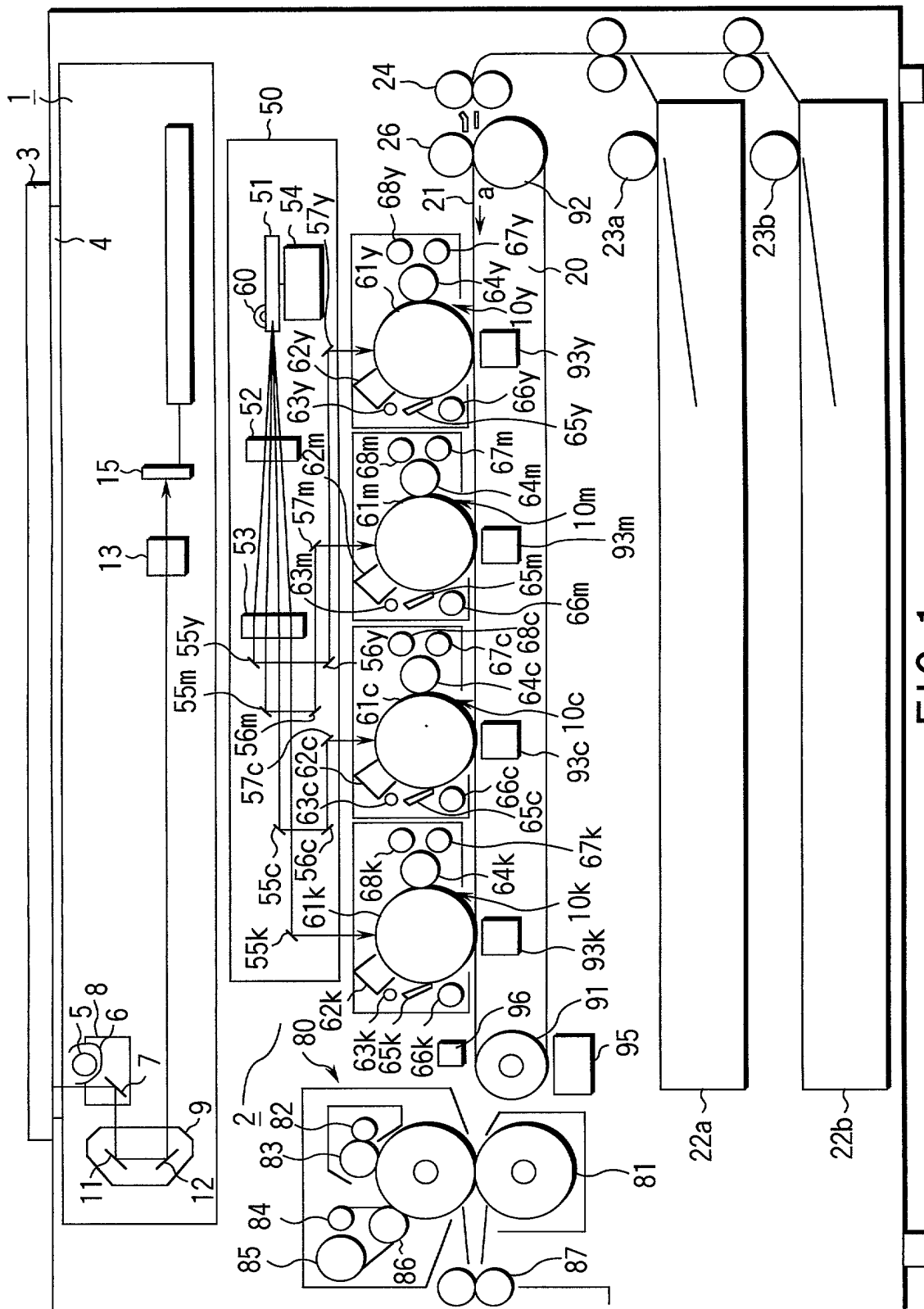


FIG.1

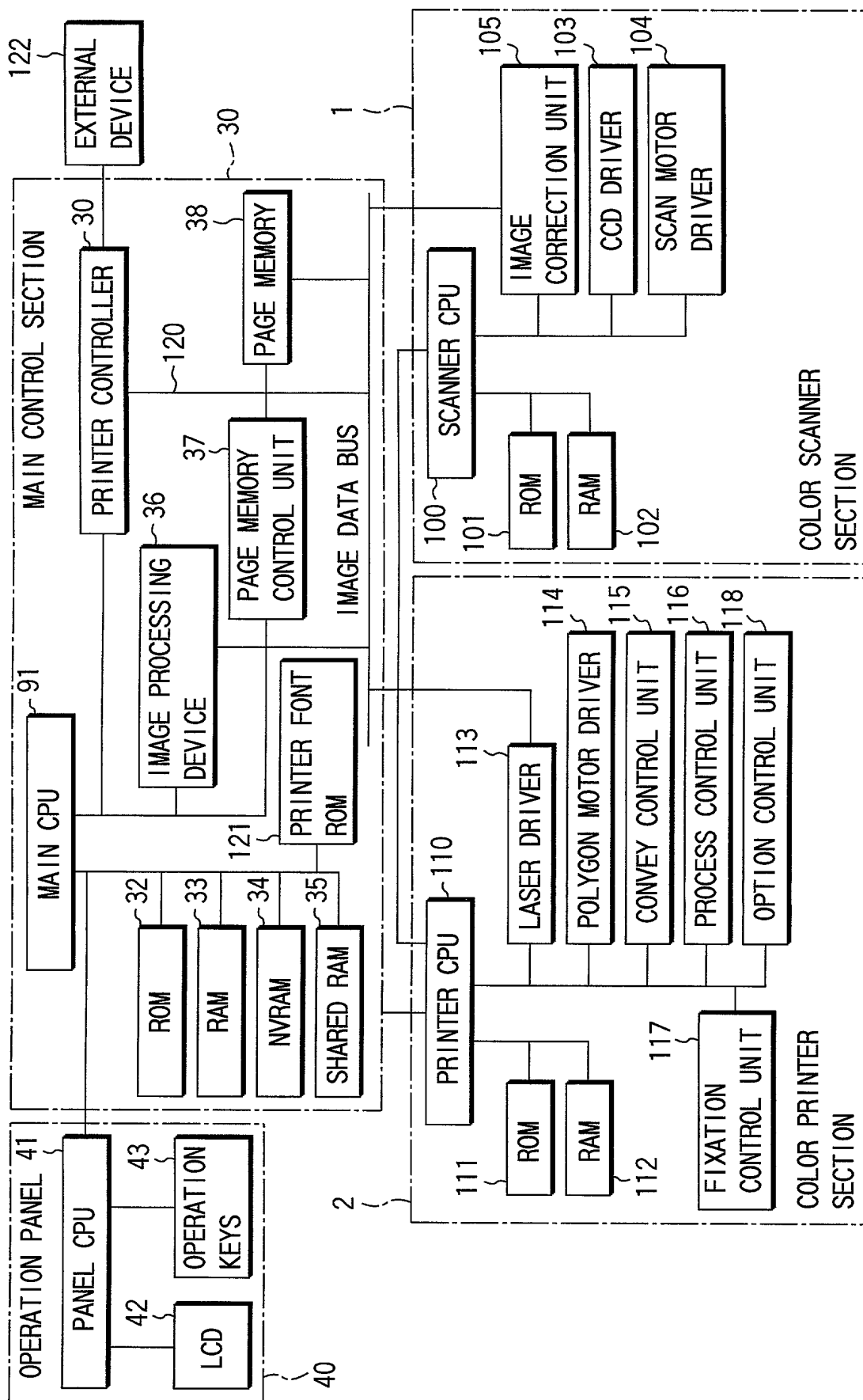


FIG. 2

232

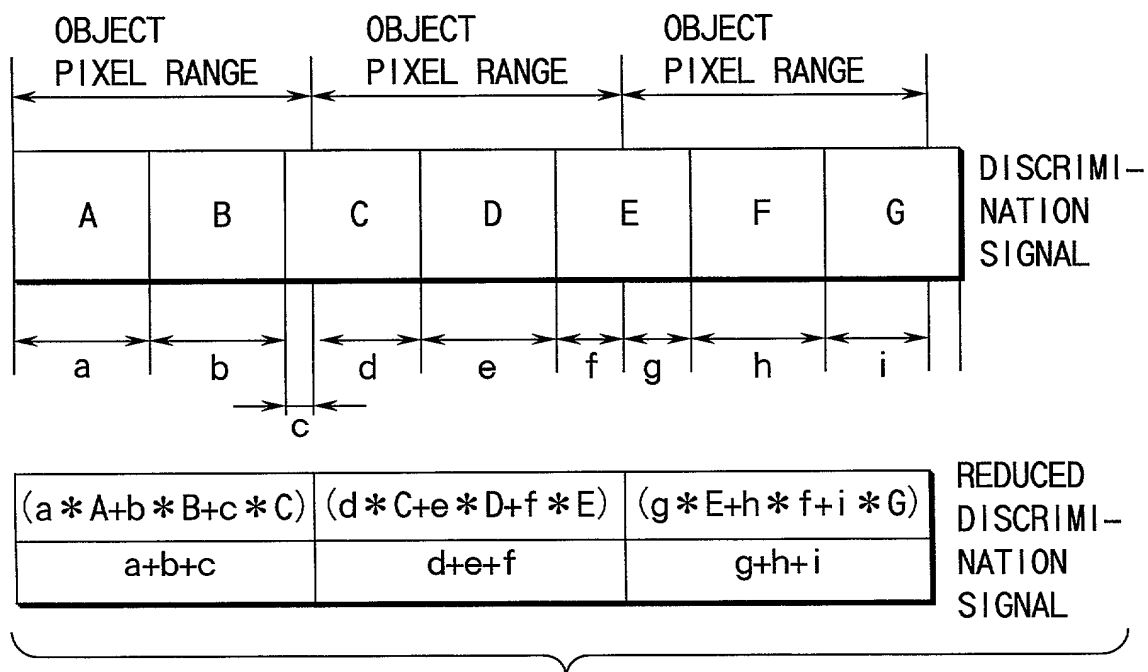


FIG. 9

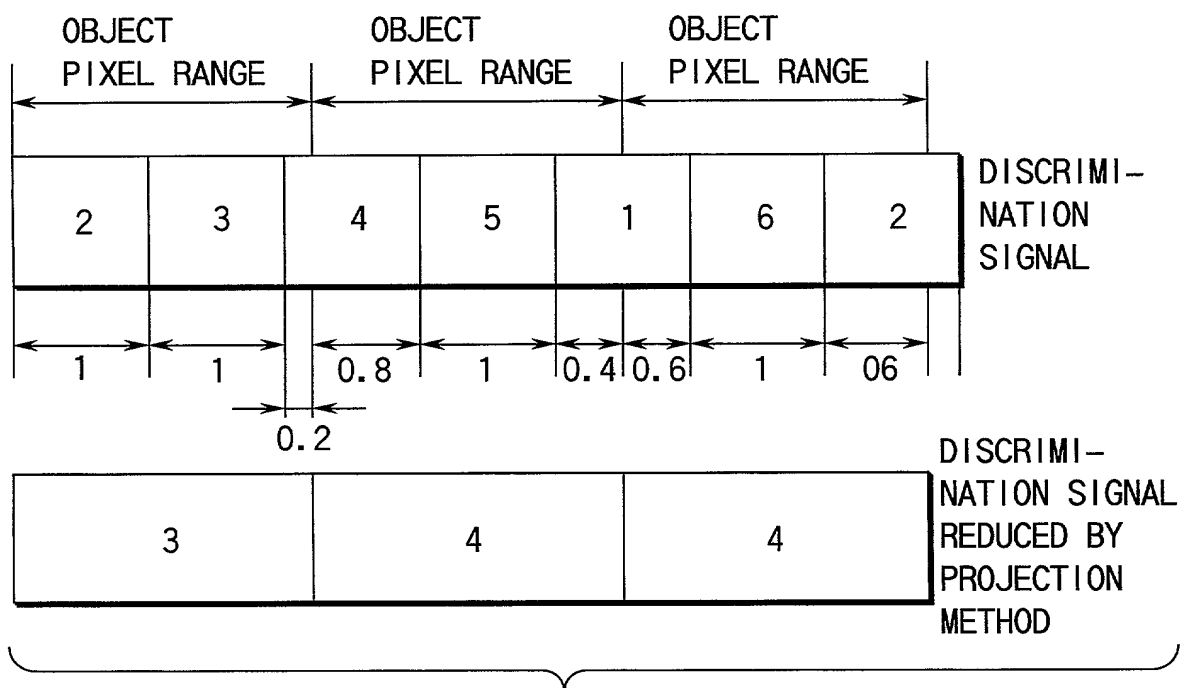


FIG. 10

As a below named inventor, I declare:
that I verily believe myself to be the original, first and sole (if only one individual inventor is listed below) or an original, first and joint inventor (if more than one individual inventor is listed below) of the invention in

the specification of which is attached hereto unless the following box is checked.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information of which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365 (b) of any foreign application(s) for patent or inventor's certificate, or 35 U.S.C. 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed:

<u>Country</u>	<u>Category</u>	<u>Application No.</u>	<u>Filing Date</u>	<u>Priority Claim</u>
Japan	Patent	11-232735	August 19, 1999	Yes

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I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I declare further that my citizenship, residence and post office address are as stated below next to my name:

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Date:

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Naoko HAMAMURA *et al.*
Title: IMAGE FORMING APPARATUS AND IMAGE FORMING METHOD
Appl. No.: Not yet assigned
Filing Date: August 18, 2000
Examiner: Not yet assigned
Art Unit: Not yet assigned

ASSOCIATE POWER OF ATTORNEY

Sir:

The undersigned attorney of record hereby grants Johnny A. Kumar, Reg. No. 34,649, an associate power with full powers of substitution and revocation to prosecute the above-identified application and transact all business in the Patent and Trademark Office connected therewith.

Respectfully submitted,

Aug. 18, 2000
Date

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